DOCUMENT 1/1
DOCUMENT NUMBER
@: unavailable

1. JP,2000-091999,A

DETAIL JAPANESE

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2000-091999**
(43)Date of publication of application : **31.03.2000**

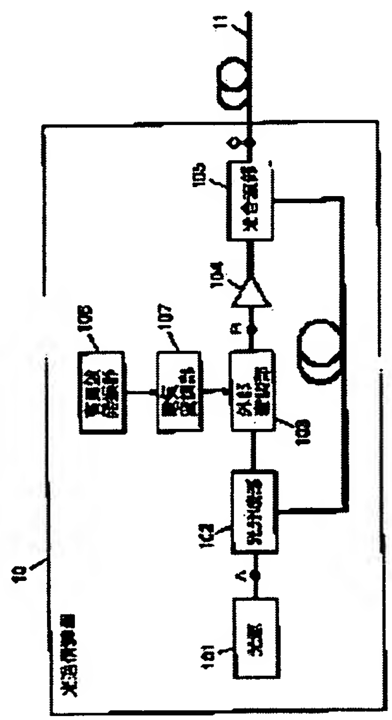
(51)Int.CI. H04B 10/152
H04B 10/142
H04B 10/04
H04B 10/06
H04B 10/28
H04B 10/26
H04B 10/14

(21)Application number : **10-259009**
(22)Date of filing : **11.09.1998**

(71)Applicant : **MATSUSHITA ELECTRIC IND CO LTD**

(72)Inventor : **MASUDA KOICHI**
SASAI HIROYUKI
MAEDA KAZUKI
FUSE MASARU
MORIKURA SUSUMU

(54) OPTICAL TRANSMISSION SYSTEM



(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical transmission system that an optical modulation degree of an optical signal obtained through modulation is sufficiently increased to increase a signal power after photoelectric conversion at a receiver side even when power of an electric signal (a modulated high frequency signal) received by an external modulation section at a transmitter side is not so much increased.
SOLUTION: An external modulation section 103 applies intensity modulation to one optical obtained from two distributed signals by an optical branching section 102 with an output signal of an electric modulation section 107 (a modulated high frequency signal). The external modulation section 103 receives a bias voltage to minimize an optical power of its output signal to suppress a carrier component and outputs only a side band. An optical amplifier section 104 amplifies the output signal from the external modulation section 103. An optical multiplexing section 105 multiplexes an output signal from the optical amplifier section 104 and the other

BACK NEXT
MENU SEARCH
HELP

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] More specifically, this invention relates to the subcarrier lightwave transmission system which carries out optical transmission of the modulated high frequency signal (especially signal of a millimeter wave band) about a lightwave transmission system.
[0002]
[Description of the Prior Art] As a light modulation method used with the subcarrier lightwave transmission system which carries out optical transmission of the high frequency signal of high frequency bands, such as a microwave band and a millimeter wave band, there are two kinds of methods, a reactance modulation system and an external modulation method. Since it is common to the RF signal of a millimeter wave band to use an external modulation method, the system which used the external modulation method is explained here. About subcarrier optical transmission, in addition, for example "Microwave andmillimeter-wave fiber optic technologies for subcarrier transmission systems" () [Hiroyo] Ogawa IEICE Transactions on Communications vol.E76-B No.9 pp 1078-1090 September It is described in detail by 1993.
[0003] The conventional lightwave transmission system using an external modulation method is shown in drawing 9 . The conventional lightwave transmission system is equipped with the optical sending set 90 and the optical receiving set 92 in drawing 9 . The optical sending set 90 and the optical receiving set 92 are connected through the optical fiber 91. The optical sending set 90 contains the light source 901, the external modulation section 902, a high-frequency oscillator 903, the electric modulation section 904, and the RF amplifier 905. The optical receiving set 92 contains a photoelectricity transducer. Below, in the conventional lightwave transmission system constituted as mentioned above, signs that a lightwave signal is transmitted to the optical receiving set 92 through an optical fiber 91 from the optical sending set 90 are explained. In the optical sending set 90, a RF signal (subcarrier) is outputted with a high-frequency oscillator 903, and the RF signal is modulated with the electrical signal which should be transmitted in the electric modulation section 904. And it is amplified by the high frequency amplifier 905 to desired level, and is inputted into the external modulation section 902. On the other hand, the lightwave signal (main carrier) for conveying a RF signal is outputted from the light source 901, and is given to the external modulation section 902. The external modulation section 902 carries out intensity modulation of the given lightwave signal according to the inputted RF signal. At this time, as shown in drawing 10 , bias voltage from which the optical output from there serves as mesial magnitude of the maximum output is applied, and the external modulation section 902 performs intensity modulation actuation in the external modulation section 902 by making that electrical potential difference into a reference point (this electrical potential difference is called the operating point of the external modulation section 902). By doing so, it is because the optical output property of the external modulation section 902 becomes the closest to linearity. Thus, the modulated lightwave signal spreads the inside of an optical fiber 91, and reaches to the optical receiving set 92. In the optical receiving set 92, photoelectricity conversion of the lightwave signal which reached is carried out by the photoelectricity

transducer 921. Thereby, in a receiving side, a RF signal can be acquired as a part for the on-the-strength strange preparation of a lightwave signal.

[0004]

[Problem(s) to be Solved by the Invention] By the way, when carrying out optical transmission of the signal of a RF band (especially millimeter wave band) in the above-mentioned conventional lightwave transmission system, in order to enlarge signal power after photoelectricity conversion, it is necessary to raise whenever [light modulation / of the lightwave signal given to the photoelectricity transducer 921], or to enlarge optical power of the lightwave signal. The relation between the optical power of a lightwave signal which gives the relation between whenever [light modulation / of the lightwave signal given to the photoelectricity transducer 921], and the signal power after photoelectricity conversion to drawing 11 at the photoelectricity transducer 921 again at drawing 12 , and the signal power after photoelectricity conversion is shown. The signal power after photoelectricity conversion becomes large as shown in drawing 11 and 12, so that whenever [light modulation / of a lightwave signal] is raised, and, so that optical power of a lightwave signal is enlarged.

[0005] However, since the maximum of the optical power which can be inputted exists in the photoelectricity transducer 921, the lightwave signal of big power cannot be inputted beyond the value.

[0006] What is necessary is on the other hand, just to enlarge level of the input signal (modulated high frequency signal) to the external modulation section 902, in order to raise whenever [light modulation / of a lightwave signal]. The relation of whenever [light modulation / of the level of the input signal to the external modulation section 902 and the lightwave signal outputted from there] is shown in drawing 13 for reference. however, the high speed steel with which the RF amplifier 905 of the preceding paragraph will be satisfied of the severe conditions of the high saturation point if it is going to enlarge level of an input signal -- a peck.

[0007] So, even if the purpose of this invention does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section by the transmitting side so much, it is offering the lightwave transmission system which can fully raise whenever [light modulation / of the lightwave signal modulated and acquired], consequently can enlarge signal power after the photoelectricity conversion by the receiving side.

[0008]

[The means for solving a technical problem and an effect of the invention] The 1st invention is a lightwave transmission system which carries out optical transmission of the modulated RF signal. To a transmitting side The optical tee, high-frequency oscillator which dichotomize the lightwave signal outputted from the light source and the light source, The electric modulation section which modulates the RF signal outputted from a high-frequency oscillator with the electrical signal which should be transmitted, Bias voltage from which the optical power of the output signal serves as min is applied. The optical tee dichotomized, and it was obtained and has the optical multiplexing section which multiplexs the output signal of the external modulation section which carries out intensity modulation of the lightwave signal with the output signal of the electric modulation section while the optical amplification section which amplifies the output signal of the external modulation section, and the optical amplification section, and the

lightwave signal of another side obtained by an optical tee dichotomizing.

[0009] In the 1st above-mentioned invention, since only a sideband is outputted from the external modulation section, a sideband can be amplified alternatively. Therefore, even if it does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section so much, by making the amplification factor of the optical amplification section high, whenever [light modulation / which is defined by the ratio of the power of a carrier component and the power of a sideband] can fully be raised, consequently signal power after the photoelectricity conversion by the receiving side can be enlarged.

[0010] In the 1st invention, the 2nd invention extracted the carrier component, the upper sideband, and the lower sideband from the output signal of the multiplexing section to the receiving side, and equips it with the 2nd photoelectricity transducer which carries out photoelectricity conversion of the sideband and carrier component of the optical separation section divided into one sideband, the sideband of another side, and the carrier component concerned among the upper sideband concerned and the lower sideband concerned, the 1st photoelectricity transducer which carries out photoelectricity conversion of one sideband, and another side.

[0011] According to the 2nd above-mentioned invention, simultaneous transmission with a high frequency signal and baseband signaling is attained.

[0012] The 3rd invention contains a fiber grating which the optical separation section makes penetrate one sideband, and reflects the sideband and carrier component of another side in the 2nd invention.

[0013] The 4th invention contains a fiber grating which the optical separation section reflects [grating] one sideband, and makes the sideband and carrier component of another side penetrate in the 2nd invention.

[0014] According to the 3rd or 4th above-mentioned invention, one sideband, the sideband of another side, and separation with a carrier component can be easily performed among an upper sideband and a lower sideband.

[0015] 5th invention is characterized by the optical amplification section having an amplification factor to which the optical power of the output signal does not exceed the power of the lightwave signal of another side in the 1st invention.

[0016] According to the 5th above-mentioned invention, since whenever [light modulation / of a lightwave signal] does not exceed 100%, it is lost that clipping arises at the time of photoelectricity conversion, and the property of the electrical signal acquired deteriorates.

[0017] 6th invention is characterized by the optical amplification section having an amplification factor whose optical power of the output signal corresponds with the power of the lightwave signal of another side in the 1st invention.

[0018] According to the 6th above-mentioned invention, since whenever [light modulation / of a lightwave signal] becomes 100% exactly, when photoelectricity conversion of the lightwave signal is carried out, an electrical signal with the largest power is acquired as an electrical signal without property degradation.

[0019] The 7th invention is a lightwave transmission system which carries out optical transmission of the modulated RF signal. To a transmitting side The optical tee, high-frequency oscillator which trifurcate the lightwave signal outputted from the light source and the light source, The electric modulation section which modulates the RF signal

outputted from a high-frequency oscillator with the electrical signal which should be transmitted, Bias voltage from which the optical power of the output signal serves as min is applied. The external modulation section which carries out intensity modulation of the 1st lightwave signal with which an optical tee is obtained by trifurcating with the output signal of the electric modulation section, The optical separation section which extracts and separates an upper sideband and a lower sideband from the output signal of the optical amplification section which amplifies the output signal of the external modulation section, and an amplifier, and an upper sideband, It has the optical multiplexing section which multiplexs the optical multiplexing section which multiplexs the 2nd lightwave signal with which an optical tee is obtained by trifurcating and a lower sideband, and the 3rd lightwave signal with which an optical tee is obtained by trifurcating.

[0020] According to the 7th above-mentioned invention, since only a sideband is outputted from the external modulation section, a sideband can be amplified alternatively. Therefore, even if it does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section so much, by making the amplification factor of the optical amplification section high, whenever [light modulation / which is defined by the ratio of the power of a carrier component and the power of a sideband] can fully be raised, consequently signal power after the photoelectricity conversion by the receiving side can be enlarged. Moreover, since an upper sideband and a lower sideband can be transmitted separately, un-arranging [for which the phase of the double sideband which spreads the inside of an optical fiber is mutually reversed, and a signal is extinguished at the time of light-receiving] is lost.

[0021] The 8th invention contains a fiber grating which the optical separation section makes penetrate one sideband among an upper sideband and a lower sideband, and reflects the sideband of another side in the 7th invention.

[0022] According to the 8th above-mentioned invention, separation with an upper sideband and a lower sideband can be performed easily.

[0023] 9th invention is characterized by the optical amplification section having an amplification factor to which the optical power of the output signal does not exceed the sum of the power of the 2nd lightwave signal, and the power of the 3rd lightwave signal in the 7th invention.

[0024] According to the 9th above-mentioned invention, since whenever [light modulation / of a lightwave signal] does not exceed 100%, it is lost that clipping arises at the time of photoelectricity conversion, and the property of the electrical signal acquired deteriorates.

[0025] 10th invention is characterized by the optical amplification section having an amplification factor whose optical power of the output signal corresponds with the sum of the power of the 2nd lightwave signal, and the power of the 3rd lightwave signal in the 7th invention.

[0026] According to the 10th above-mentioned invention, since whenever [light modulation / of a lightwave signal] becomes 100% exactly, when photoelectricity conversion of the lightwave signal is carried out, an electrical signal with the largest power is acquired as an electrical signal without property degradation.

[0027] The 11th invention is a lightwave transmission system which carries out optical transmission of the modulated RF signal. To a transmitting side The optical tee, high-frequency oscillator which dichotomize the lightwave signal outputted from the light

source and the light source, The electric modulation section which modulates the RF signal outputted from a high-frequency oscillator with the electrical signal which should be transmitted, Bias voltage from which the optical power of the output signal serves as min is applied. The external modulation section to which an optical tee dichotomizes, while is obtained and intensity modulation of the lightwave signal is carried out with the output signal of the electric modulation section, Among the optical separation section which extracts and separates an upper sideband and a lower sideband from the output signal of the optical amplification section which amplifies the output signal of the external modulation section, and an amplifier, an upper sideband, and a lower sideband, one sideband, It had the optical multiplexing section which multiplexs the lightwave signal of another side where an optical tee is obtained by dichotomizing, and the receiving side is equipped with the 1st photoelectricity transducer which carries out photoelectricity conversion of the sideband of another side among an upper sideband and a lower sideband, and the 2nd photoelectricity transducer which carries out photoelectricity conversion of the output signal of the multiplexing section.

[0028] According to the 11th above-mentioned invention, since only a sideband is outputted from the external modulation section, a sideband can be amplified alternatively. Therefore, even if it does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section so much, by making the amplification factor of the optical amplification section high, whenever [light modulation / which is defined by the ratio of the power of a carrier component and the power of a sideband] can fully be raised, consequently signal power after the photoelectricity conversion by the receiving side can be enlarged. Moreover, since an upper sideband and a lower sideband can be transmitted separately, un-arranging [for which the phase of the double sideband which spreads the inside of an optical fiber is mutually reversed, and a signal is extinguished at the time of light-receiving] is lost. Furthermore, simultaneous transmission with a high frequency signal and baseband signaling is attained.

[0029] The 12th invention contains a fiber grating which the optical separation section makes penetrate one sideband among an upper sideband and a lower sideband, and reflects the sideband of another side in the 11th invention.

[0030] According to the 12th above-mentioned invention, separation with an upper sideband and a lower sideband can be performed easily.

[0031] The 13th invention is characterized by the optical amplification section having an amplification factor to which the optical power of one sideband does not exceed the power of the lightwave signal of another side in the 11th invention.

[0032] According to the 13th above-mentioned invention, since whenever [light modulation / of a lightwave signal] does not exceed 100%, it is lost that clipping arises at the time of photoelectricity conversion, and the property of the electrical signal acquired deteriorates.

[0033] The 14th invention is characterized by the optical amplification section having an amplification factor whose optical power of one sideband corresponds with the power of the lightwave signal of another side in the 11th invention.

[0034] According to the 14th above-mentioned invention, since whenever [light modulation / of a lightwave signal] becomes 100% exactly, when photoelectricity conversion of the lightwave signal is carried out, an electrical signal with the largest power is acquired as an electrical signal without property degradation.

[0035]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained, referring to a drawing.
(1st operation gestalt) Drawing 1 is the block diagram showing the configuration of the optical sending set concerning the 1st operation gestalt of this invention. The optical sending set 10 is equipped with the light source 101, the optical tee 102, the external modulation section 103, the optical amplification section 104, the optical multiplexing section 105, a high-frequency oscillator 106, and the electric modulation section 107 in drawing 1 . In addition, it connects with the optical receiving set (not shown) through the optical fiber 11, and the optical sending set 10 transmits a lightwave signal to an optical receiving set through an optical fiber 11.
[0036] The light source 101 outputs a lightwave signal. The optical tee 102 dichotomizes a lightwave signal. A high-frequency oscillator 106 outputs a RF signal. The electric modulation section 107 modulates a RF signal with an electrical signal. The optical tee 102 dichotomizes, while was obtained and the external modulation section 103 modulates a lightwave signal by the modulated RF signal. The optical amplification section 104 amplifies the modulated lightwave signal. The optical multiplexing section 105 multiplexs the lightwave signal of another side where the optical tee 102 was obtained by dichotomizing, and the amplified lightwave signal.
[0037] Drawing 2 is the mimetic diagram showing the spectrum of the lightwave signal transmitted in each point of A-C in the optical sending set 10 of drawing 1 . Hereafter, the optical sending set 10 constituted as mentioned above explains the actuation which transmits a lightwave signal using drawing 2 . In the optical sending set 10, at first, a high frequency signal (subcarrier) is outputted from high frequency oscilator 106, and is given to the electric modulation section 107 from it with the electrical signal which is the baseband signaling which should be transmitted. The electric modulation section 107 modulates the given RF signal with an electrical signal. In this way, the modulated RF signal is given to the external modulation section 103.
[0038] The lightwave signal (main carrier) which, on the other hand, has spectrum as shown in drawing 2 (1) from the light source 101 is outputted. The lightwave signal which has a carrier component in a frequency fc dichotomizes by the optical tee 102, while was obtained and, as for the lightwave signal of another side, a lightwave signal is given to the external modulation section 103 at the optical multiplexing section 105. While was given and the external modulation section 103 carries out intensity modulation of the lightwave signal by the modulated RF signal.
[0039] Bias voltage from which that optical output serves as min is applied to the external modulation section 103, and the external modulation section 103 performs intensity modulation actuation for that electrical potential difference as criteria (core of the amplitude) (this electrical potential difference is called the operating point of the external modulation section 103). The operating point of the external modulation section 103 is shown in drawing 3 . At this time, the output of the external modulation section 103 serves as a lightwave signal with spectrum as shown in drawing 2 (2). That is, in the lightwave signal modulated by the external modulation section 103, the above-mentioned carrier component was oppressed and the sideband has arisen in the right and left (namely, a frequency higher than fc and a frequency lower than fc), respectively. Each [these] sideband is called an upper sideband and a lower sideband.

[0040] After the lightwave signal outputted from the external modulation section 103 is amplified by the optical amplification section 104, it is inputted into the optical multiplexing section 105. The optical multiplexing section 105 multiplexs and sends out the lightwave signal inputted through the optical amplification section 104, and the lightwave signal of above-mentioned another side given from the optical tee 102 in an optical fiber 11. At this time, the output of the optical multiplexing section 105 serves as a lightwave signal with spectrum as shown in drawing 2 (3). That is, the above-mentioned carrier component and the amplified double sideband are contained in the lightwave signal transmitted from the optical sending set 10. In this way, the lightwave signal transmitted from the optical sending set 10 spreads the inside of an optical fiber 11, and reaches to an optical receiving set. In an optical receiving set, processing which carries out photoelectricity conversion of the lightwave signal which reached is performed.
[0041] As mentioned above, in the optical sending set 10, a carrier component is oppressed and only the sideband is made to be outputted by setting the operating point of the external modulation section 103 as the location of drawing 3 from the external modulation section 103. By doing so, whenever [light modulation / which can amplify a sideband now alternatively, consequently is defined by the ratio of the power of a carrier component and the power of a sideband] can be raised. Therefore, even if it does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section 103 so much unlike the conventional optical sending set (for example, optical sending set 90 of drawing 9), whenever [light modulation / of a lightwave signal] can fully be raised by making high the amplification factor of the optical amplification section 104.
[0042] Here, in the conventional optical sending set 90, the case where the optical amplification section is prepared immediately after the external modulation section 902 is considered for reference. In this case, since the operating point of the external modulation section 902 is set as the location of drawing 10 , a carrier component and a sideband are outputted from the external modulation section 902. Therefore, a carrier component and a sideband will be amplified and whenever [light modulation] goes up by neither of optical amplification section.
[0043] By the way, in the optical sending set 10, while the electrical signal of big power comes to be acquired when photoelectricity conversion of the lightwave signal is carried out by the optical receiving set side since whenever [light modulation / of a lightwave signal] can be easily raised only by making high the amplification factor of the optical amplification section 104, the following problems arise. That is, when the amplification factor of the optical amplification section 104 is too high and whenever [light modulation / of a lightwave signal] exceeds 100%, it is the problem on which clipping arises at the time of photoelectricity conversion, and the property of the electrical signal acquired deteriorates. For this reason, it is desirable to set the amplification factor of the optical amplification section 104 as a value which the power of a double sideband becomes below the power of a carrier component so that whenever [light modulation / of a lightwave signal] may not exceed 100%.
[0044] It is most desirable to set the amplification factor of the optical amplification section 104 as a value to which the power of a double sideband becomes equal to the power of a carrier component, and to make it whenever [light modulation / of a

lightwave signal] become 100% exactly by it. make -- it is because an electrical signal with the largest power is acquired as an electrical signal without property degradation in that case when photoelectricity conversion of the lightwave signal is carried out, **** and.

[0045] In addition, application to the new radio communications system which used the RF signal of for example, a millimeter wave band is possible for this operation gestalt. In that case, an antenna is formed in an optical receiving set and a RF signal is emitted to space.

[0046] By the way, if the lightwave signal is modulated by the RF signal which is millimeter wave band extent when transmitting the lightwave signal of 1.5-micrometer band using the single mode fiber for the lightwave signals of 1.3-micrometer band currently generally used That disappearance of the modulation component by wavelength dispersion arises in several km Reference (U.) [Gliese,] [et] al., "Chromatic dispersion in fibre-optic microwave and millimeter-wave links", IEEETrans.Microwave Theory Tech., vol.44, No.10 It is describing 1996 etc. Here, specifically, disappearance of the modulation component by wavelength dispersion means the following phenomena. namely, the time of the lightwave signal spreading the inside of an optical fiber -- between the above-mentioned upper sideband and lower sidebands -- phase contrast -- being generated -- just -- being alike -- it becomes opposition. When an optical receiving set receives a lightwave signal in such phase relation, the beat component of an optical subcarrier and an upper sideband and the beat component of an optical subcarrier and a lower sideband will be mutually offset at the time of light-receiving, consequently a signal (modulation component) will be extinguished. With the 2nd operation gestalt explained below, the optical sending set which can prevent disappearance of the signal by this wavelength dispersion is indicated.

[0047] (2nd operation gestalt) Drawing 4 is the block diagram showing the configuration of the optical sending set concerning the 2nd operation gestalt of this invention. The optical sending set 20 is equipped with the light source 201, the optical tee 202, the external modulation section 203, the optical multiplexing sections 205a and 205b of the 204 or 2 optical amplification sections, a high-frequency oscillator 206, the electric modulation section 207, and the optical separation section 208 in drawing 4 . In addition, it connects with two optical receiving sets (not shown) through two optical fibers 21a and 21b, and the optical sending set 20 transmits a lightwave signal to each optical receiving set through each optical fiber (21a, 21b).

[0048] The light source 201 outputs a lightwave signal. The optical tee 202 trifurcates a lightwave signal. A high-frequency oscillator 206 outputs a RF signal. The electric modulation section 207 modulates a RF signal with an electrical signal. The external modulation section 203 modulates the 1st lightwave signal with which the optical tee 202 was obtained by trifurcating by the modulated RF signal. The optical amplification section 204 amplifies the modulated lightwave signal. The optical separation section 208 extracts and separates an upper sideband and a lower sideband from the output of the optical amplification section 204, and gives them to each optical multiplexing section (205a, 205b). Optical multiplexing section 205a multiplexs the 2nd lightwave signal with which the optical tee 202 was obtained by trifurcating, and the amplified lightwave signal (here upper sideband). Optical multiplexing section 205b multiplexs the 3rd lightwave signal with which the optical tee 202 was obtained by trifurcating, and the amplified

lightwave signal (here lower sideband).

[0049] Drawing 5 is the mimetic diagram showing the spectrum of the lightwave signal transmitted in each point of D and E in the optical sending set 20 of drawing 4 . Hereafter, the optical sending set 20 constituted as mentioned above explains the actuation which transmits a lightwave signal using drawing 2 (refer to the 1st operation gestalt) and drawing 5 . Theoretically, actuation of the optical sending set 20 of drawing 4 is the same as actuation of the optical sending set 10 of drawing 1 explained with the 1st operation gestalt. Then, only a stop and different actuation are explained to a detail explaining an outline about the same actuation as the equipment of drawing 1 . In the optical sending set 20, at first, a high frequency signal (subcarrier) is outputted from high frequency oscilator 206, and is given to the electric modulation section 207 from it with the electrical signal which is the baseband signaling which should be transmitted. The electric modulation section 207 modulates the given RF signal with an electrical signal. In this way, the modulated RF signal is given to the external modulation section 203.

[0050] The lightwave signal (main carrier) which, on the other hand, has spectrum as shown in drawing 2 (1) from the light source 201 is outputted. The lightwave signal which has a carrier component in a frequency fc trifurcates by the optical tee 202, and, as for the 2nd and 3rd lightwave signals, the 1st acquired lightwave signal is given to the external modulation section 203 at each optical multiplexing section (205a, 205b). The external modulation section 203 carries out intensity modulation of the 1st given lightwave signal by the modulated RF signal.

[0051] Bias voltage from which the optical output serves as min is applied to the external modulation section 203, and the external modulation section 203 performs intensity modulation actuation on the basis of the electrical potential difference (operating point). The operating point of the external modulation section 203 is the same as that of what shows drawing 3 . At this time, the output of the external modulation section 203 serves as a lightwave signal with spectrum as shown in drawing 2 (2). That is, in the lightwave signal modulated by the external modulation section 203, the above-mentioned carrier component was oppressed and the sideband has arisen in the right and left.

[0052] After the lightwave signal outputted from the external modulation section 203 is amplified by the optical amplification section 204, it is inputted into the optical separation section 208. Drawing 6 is the block diagram showing the configuration of the optical separation section 208 of drawing 4 . In drawing 6 , the optical separation section 208 contains an optical circulator 2081 and the fiber grating 2082. The fiber grating 2082 is an optic which has the property to mince two or more diffraction gratings to the optical medium formed for example, in the shape of a cylindrical shape, to pass alternatively the signal of a specific band (band which is equivalent to the above-mentioned upper sideband here), and to reflect the signal of other bands.

[0053] The lightwave signal inputted into the optical separation section 208 passes an optical circulator 2081, and reaches the fiber grating 2082. An upper sideband penetrates that among the lightwave signals (an upper sideband and lower sideband) which reached the fiber grating 2082, and a lower sideband is reflected. Therefore, the penetrated upper sideband is outputted to the optical multiplexing section 205a side, and the reflected lower sideband passes an optical circulator 2081 again, and is outputted to the optical multiplexing section 205b side.

[0054] Optical multiplexing section 205a multiplexs and sends out the lightwave signal

(upper sideband) inputted through the optical separation section 208, and the 2nd lightwave signal (carrier component) of the above given from the optical tee 202 in optical fiber 21a. At this time, the output of optical multiplexing section 205a serves as a lightwave signal with spectrum as shown in drawing 5 (1). On the other hand, optical multiplexing section 205b multiplexs and sends out the lightwave signal (lower sideband) inputted through the optical separation section 208, and the 3rd lightwave signal (carrier component) of the above given from the optical tee 202 in optical fiber 21b. At this time, the output of optical multiplexing section 205b serves as a lightwave signal with spectrum as shown in drawing 5 (2).

[0055] That is, the above-mentioned carrier component and the amplified upper sideband are contained in the lightwave signal transmitted through optical fiber 21a, and the above-mentioned carrier component and the amplified lower sideband are contained in the lightwave signal transmitted through optical fiber 21b. In this way, two lightwave signals transmitted from the optical sending set 20 reach to each optical receiving set. In each optical receiving set, processing which carries out photoelectricity conversion of the lightwave signal which reached is performed.

[0056] As mentioned above, even if it does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section 203 so much unlike the conventional optical sending set, whenever [light modulation / of a lightwave signal] can fully be raised in the optical sending set 20 by making high the amplification factor of the optical amplification section 204.

[0057] Moreover, in the optical sending set 20, since an upper sideband and a lower sideband can be transmitted through a separate optical fiber (21a, 21b) unlike the optical sending set 10 of drawing 1 , un-arranging [for which the phase of the double sideband which spreads the inside of an optical fiber is mutually reversed, and a signal is extinguished at the time of light-receiving] is lost.

[0058] In addition, application to the new radio communications system which used the RF signal of for example, a millimeter wave band is possible for this operation gestalt. In that case, an antenna is formed in an optical receiving set and a RF signal is emitted to space.

[0059] Now, with the 2nd operation gestalt, although the upper sideband and the lower sideband were multiplexed with the carrier component, respectively and it transmitted, it can multiplex with a carrier component in either an upper sideband and a lower sideband instead, and can transmit, and it can also transmit as it is, without multiplexing another side with a carrier component. By it, simultaneous transmission with a high frequency signal and baseband signaling is attained. With the 3rd operation gestalt explained below, a lightwave transmission system which transmits a high frequency signal and baseband signaling to coincidence is indicated.

[0060] (3rd operation gestalt) Drawing 7 is the block diagram showing the configuration of the lightwave transmission system concerning the 3rd operation gestalt of this invention. The lightwave transmission system is equipped with the optical sending set 30 and two optical receiving sets 32a and 32b in drawing 7 . The optical sending set 30 contains the light source 301, the optical tee 302, the external modulation section 303, the optical amplification section 304, the optical multiplexing section 305, a high-frequency oscillator 306, the electric modulation section 307, and the optical separation section 308. Optical receiving set 32a contains photoelectricity transducer 321a. Optical receiving set

32b contains photoelectricity transducer 321b. It connects with two optical receiving sets 32a and 32b through two optical fibers 31a and 31b, and the optical sending set 30 transmits a lightwave signal to each optical receiving set (32a, 32b) through each optical fiber (31a, 31b).

[0061] In the optical sending set 30, the light source 301 outputs a lightwave signal. The optical tee 302 dichotomizes a lightwave signal. A high-frequency oscillator 306 outputs a RF signal. The electric modulation section 307 modulates a RF signal with an electrical signal. The optical tee 302 dichotomizes, while was obtained and the external modulation section 303 modulates a lightwave signal by the modulated RF signal. The optical amplification section 304 amplifies the modulated lightwave signal. The optical separation section 308 extracts and separates an upper sideband and a lower sideband from the output of the optical amplification section 304, gives either an upper sideband and a lower sideband (here lower sideband) to the optical multiplexing section 305, and sends out another side (here upper sideband) to optical fiber 31a. The optical tee 302 multiplexs the lightwave signal of another side obtained by dichotomizing, and the amplified lightwave signal (lower sideband), and sends out the optical multiplexing section 305 to optical fiber 31b.

[0062] In optical receiving set 32a, photoelectricity transducer 321a carries out photoelectricity conversion of the lightwave signal (baseband signaling only containing an upper sideband) sent through optical fiber 31a. On the other hand, in optical receiving set 32b, photoelectricity transducer 321b carries out photoelectricity conversion of the lightwave signal (RF signal containing a carrier component and a lower sideband) sent through optical fiber 31b.

[0063] Hereafter, in the lightwave transmission system constituted as mentioned above, the optical sending set 30 explains the actuation which transmits a lightwave signal to two optical receiving sets 32a and 32b using drawing 2 (refer to the 1st operation gestalt) and drawing 5 (refer to the 2nd operation gestalt). Actuation of the optical sending set 30 of drawing 7 is the same as actuation of the optical sending set 20 of drawing 4 explained with the 2nd operation gestalt except for the point of multiplexing with a carrier component in either an upper sideband and a lower sideband, transmitting, and transmitting another side as it is, without multiplexing with a carrier component. Then, only a stop and different actuation are explained to a detail explaining an outline about the same actuation as the equipment of drawing 4 . In the optical sending set 30, at first, a high frequency signal (subcarrier) is outputted from high frequency oscilator 306, and is given to the electric modulation section 307 from it with the electrical signal which is the baseband signaling which should be transmitted. The electric modulation section 307 modulates the given RF signal with an electrical signal. In this way, the modulated RF signal is given to the external modulation section 303.

[0064] The lightwave signal (main carrier) which, on the other hand, has spectrum as shown in drawing 2 (1) from the light source 301 is outputted. The lightwave signal which has a carrier component in a frequency fc dichotomizes by the optical tee 302, while was obtained and, as for the lightwave signal of another side, a lightwave signal is given to the external modulation section 303 at the optical multiplexing section 305. While was given and the external modulation section 303 carries out intensity modulation of the lightwave signal by the modulated RF signal.

[0065] Bias voltage from which the optical output serves as min is applied to the external

modulation section 303, and the external modulation section 303 performs intensity modulation actuation on the basis of the electrical potential difference (operating point). The operating point of the external modulation section 303 is the same as that of what shows drawing 3 . At this time, the output of the external modulation section 303 serves as a lightwave signal with spectrum as shown in drawing 2 (2). That is, in the lightwave signal modulated by the external modulation section 303, the above-mentioned carrier component was oppressed and the sideband has arisen in the right and left.

[0066] After the lightwave signal outputted from the external modulation section 303 is amplified by the optical amplification section 304, it is inputted into the optical separation section 308. The optical separation section 308 has the same configuration as what is shown in drawing 6 . That is, the fiber grating and optical circulator which are made to pass alternatively the signal of a specific band (band which is equivalent to the above-mentioned upper sideband here), and reflect the signal of other bands are contained in the optical separation section 308. Therefore, from the optical separation section 308, a lower sideband is outputted to the optical multiplexing section 305 side among lightwave signals (an upper sideband and lower sideband), and an upper sideband is outputted into optical fiber 31a.

[0067] The optical multiplexing section 305 multiplexs and sends out the lightwave signal (lower sideband) inputted through the optical separation section 308, and the lightwave signal (carrier component) of above-mentioned another side given from the optical tee 302 in optical fiber 31b. At this time, the output of the optical multiplexing section 305 serves as a lightwave signal with spectrum as shown in drawing 5 (2).

[0068] That is, the amplified upper sideband is contained in the lightwave signal transmitted through optical fiber 31a, and the above-mentioned carrier component and the amplified lower sideband are contained in the lightwave signal transmitted through optical fiber 31b. In this way, two lightwave signals transmitted from the optical sending set 30 reach to each optical receiving set (32a, 32b). In optical receiving set 32a, photoelectricity transducer 321a carries out photoelectricity conversion of the lightwave signal (baseband signaling) which reached. On the other hand, in optical receiving set 32b, photoelectricity transducer 321b carries out photoelectricity conversion of the lightwave signal (RF signal) which reached.

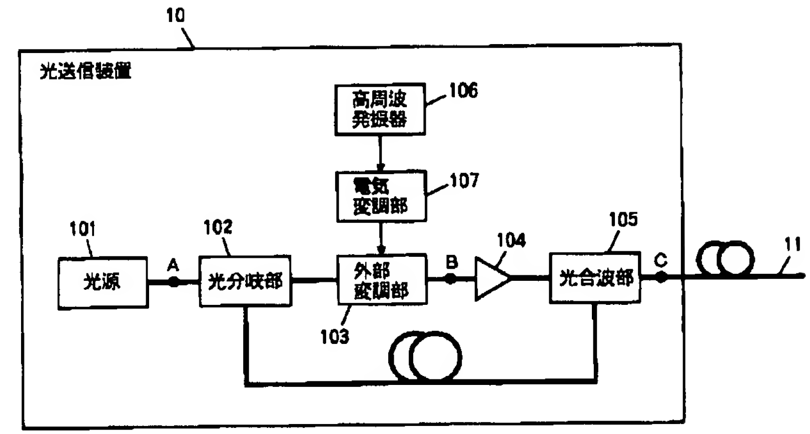
[0069] In addition, in order to prevent clipping arising in photoelectricity transducer 321b, as for the amplification factor of the optical amplification section 304, it is desirable to consider as a value to which the optical power of the amplified lower sideband does not exceed the power of the above-mentioned carrier component. It is most desirable to set the amplification factor of the optical amplification section 304 as a value to which the optical power of the amplified lower sideband becomes equal to the power of the above-mentioned carrier component, and to make it whenever [light modulation / of a lightwave signal] become 100% exactly by it. It is because an electrical signal with the largest power is acquired as an electrical signal without property degradation in that case when photoelectricity conversion of the lightwave signal is carried out.

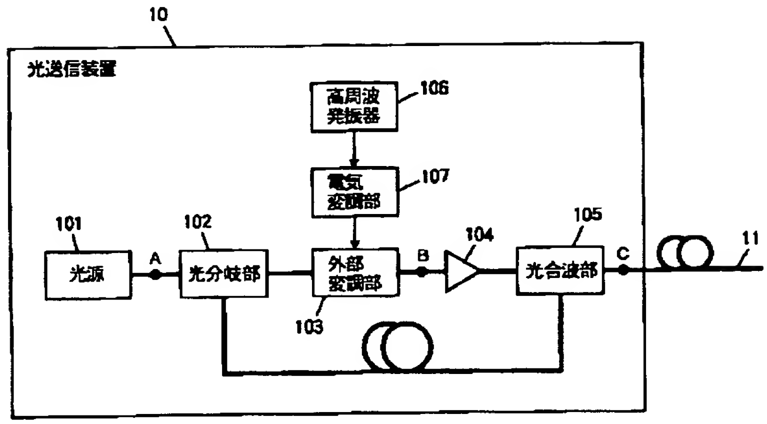
[0070] As mentioned above, even if it does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section 303 so much unlike the conventional optical sending set, whenever [light modulation / of a lightwave signal] can fully be raised in the optical sending set 30 by making high the amplification factor of the optical amplification section 304.

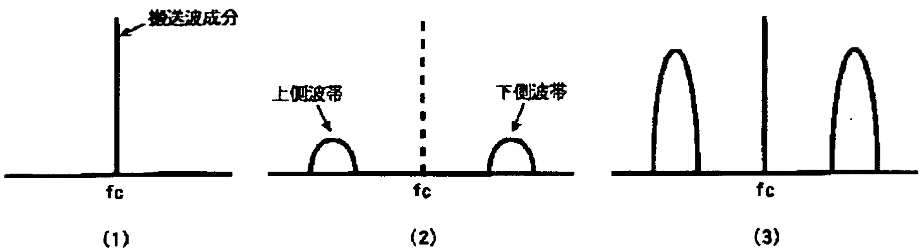
[0071] Moreover, in the optical sending set 30, since an upper sideband and a lower sideband can be transmitted through a separate optical fiber (31a, 31b) unlike the optical sending set 10 of drawing 1 , un-arranging [for which the phase of the double sideband which spreads the inside of an optical fiber is mutually reversed, and a signal is extinguished at the time of light-receiving] is lost.
[0072] Furthermore, in the optical sending set 30, since unlike the optical sending set 20 of drawing 4 it multiplexs with a carrier component in either an upper sideband and a lower sideband, it transmits and another side is transmitted as it is, without multiplexing with a carrier component, simultaneous transmission with a high frequency signal and baseband signaling is attained.
[0073] In addition, application to the new radio communications system which used the RF signal of for example, a millimeter wave band is possible for this operation gestalt. In that case, an antenna is connected to photoelectricity transducer 321b, and a RF signal is emitted to space. On the other hand, since digital data is obtained from photoelectricity transducer 321a, a personal computer can be connected and data communication can be performed.
[0074] Now, with the 4th operation gestalt explained below, the optical receiving set which realizes the lightwave transmission system which can perform simultaneous transmission with the same high frequency signal and baseband signaling as the 3rd operation gestalt is indicated by using combining the optical sending set 10 indicated with the 1st operation gestalt.
[0075] (4th operation gestalt) Drawing 8 is the block diagram showing the configuration of the lightwave transmission system concerning the 4th operation gestalt of this invention. The lightwave transmission system is equipped with the optical sending set 10 and the optical receiving set 12 in drawing 8 . The optical sending set 10 is the same as the optical sending set 10 of drawing 1 . It connects with the optical receiving set 12 through the optical fiber 11, and the optical sending set 10 transmits a lightwave signal to the optical receiving set 12 through an optical fiber 11.
[0076] The optical receiving set 12 contains the photoelectricity transducers 122a and 122b of the 121 or 2 optical separation sections. A carrier component, an upper sideband, and a lower sideband are extracted from the lightwave signal sent through an optical fiber 11, it separates into one sideband, the sideband of another side, and a carrier component among an upper sideband and a lower sideband, and the optical separation section 121 gives one sideband (here upper sideband) to photoelectricity transducer 122a, and gives the sideband (here lower sideband) and carrier component of another side to the photoelectricity conversion 122b section. Fundamental actuation of two photoelectricity transducers 122a and 122b is the same as that of what was explained with the 3rd operation gestalt. That is, photoelectricity transducer 122a carries out photoelectricity conversion of the given lightwave signal (baseband signaling only containing an upper sideband). Photoelectricity transducer 122b carries out photoelectricity conversion of the given lightwave signal (RF signal containing a carrier component and a lower sideband).
[0077] In the lightwave transmission system constituted as mentioned above, since the optical sending set 10 of the actuation which transmits a lightwave signal to the optical receiving set 12 is the same as that of what was explained with the 1st operation gestalt, explanation is omitted, and only reception actuation of the optical receiving set 12 is explained hereafter.

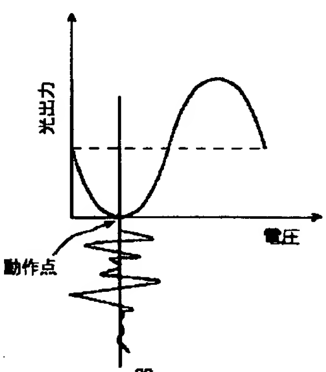
[0078] The lightwave signal which reached to the optical receiving set 12 is inputted into the optical separation section 121. The optical separation section 121 has the same configuration as what is shown in drawing 6 . That is, the fiber grating and optical circulator which are made to pass alternatively the signal of a specific band (band which is equivalent to the above-mentioned upper sideband here), and reflect the signal of other bands are contained in the optical separation section 121. Therefore, from the optical separation section 121, an upper sideband is outputted to the photoelectricity transducer 122a side among lightwave signals (a carrier component, an upper sideband, and lower sideband), and a carrier component and a lower sideband are outputted to the photoelectricity transducer 122b side.
[0079] Photoelectricity transducer 122a carries out photoelectricity conversion of the given lightwave signal (baseband signaling). On the other hand, photoelectricity transducer 122b carries out photoelectricity conversion of the given lightwave signal (RF signal).
[0080] As mentioned above, even if it does not enlarge power of the electrical signal (modulated RF signal) inputted into the external modulation section 303 so much unlike the conventional optical sending set, whenever [light modulation / of a lightwave signal] can fully be raised in the optical sending set 10 by making high the amplification factor of the optical amplification section 304.
[0081] Moreover, in the optical receiving set 12, from the sent lightwave signal, one sideband and carrier component of an upper sideband and a lower sideband were extracted, photoelectricity conversion was carried out, and the RF signal has been acquired. Moreover, photoelectricity conversion of the sideband of another side was carried out, and baseband signaling has been acquired. Therefore, simultaneous transmission with a high frequency signal and baseband signaling is attained the same by the 3rd operation gestalt as a result.
[0082] In addition, application to the new radio communications system which used the RF signal of for example, a millimeter wave band is possible for this operation gestalt. In that case, an antenna is connected to photoelectricity transducer 122b, and a RF signal is emitted to space. On the other hand, since digital data is obtained from photoelectricity transducer 122a, a personal computer can be connected and data communication can be performed.

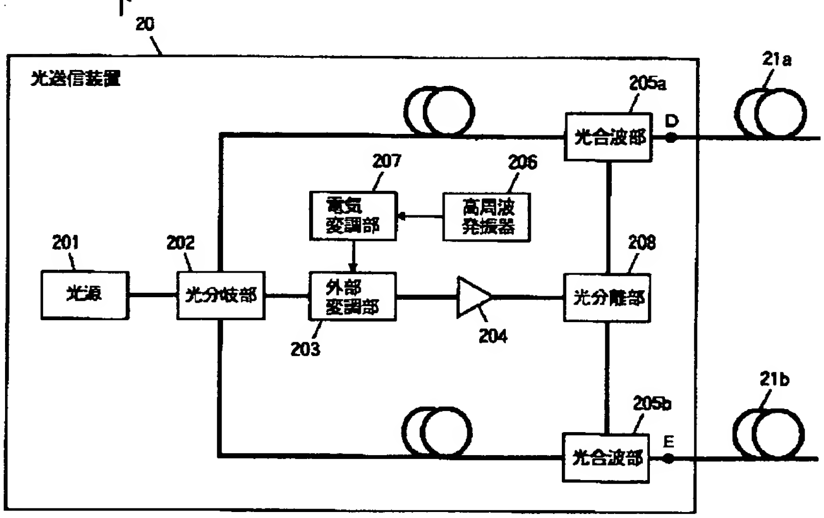
[Translation done.]

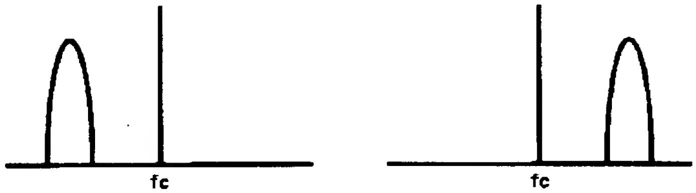

10
光送信装置
101
光源
A
102
光分岐部
外部
変調部
103
106
高周波
発振器
107
電気
変調部
B
104
105
光合波部
C
11


10
光送信装置
高周波
発振器
106
電気
変調部
107
101
102
105
104
光源
A
光分岐部
外部
変調部
B
光合波部
C
11
103

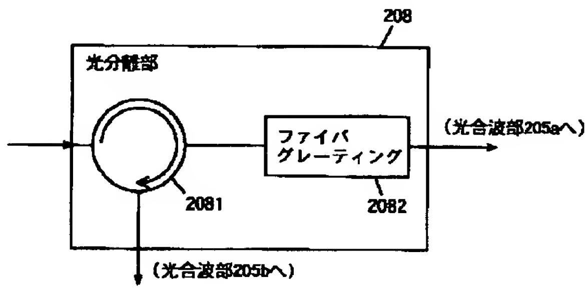

搬送波成分
上側波帯
下側波帯
fc
fc
fc
(1)
(2)
(3)

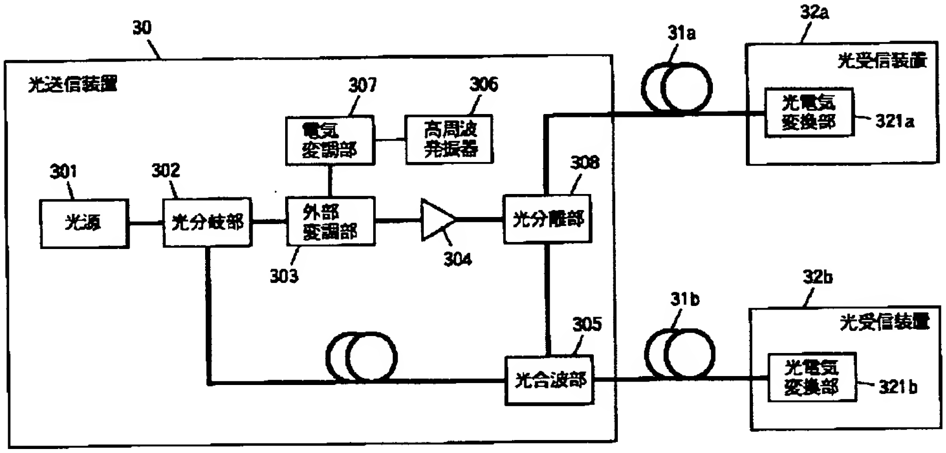

光出力
電圧
動作点

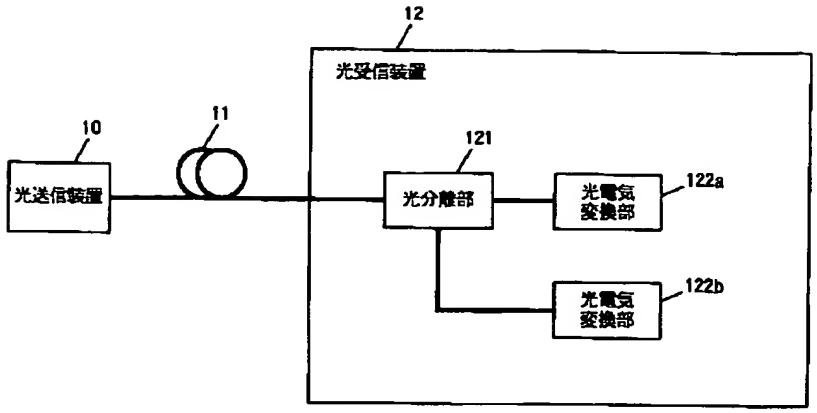

20
光送信装置
21a
205a
D
光合波部
207
206
電気
変調部
高周波
発振器
201
202
208
光源
光分岐部
外部
変調部
光分離部
203
204
21b
205b
E
光合波部

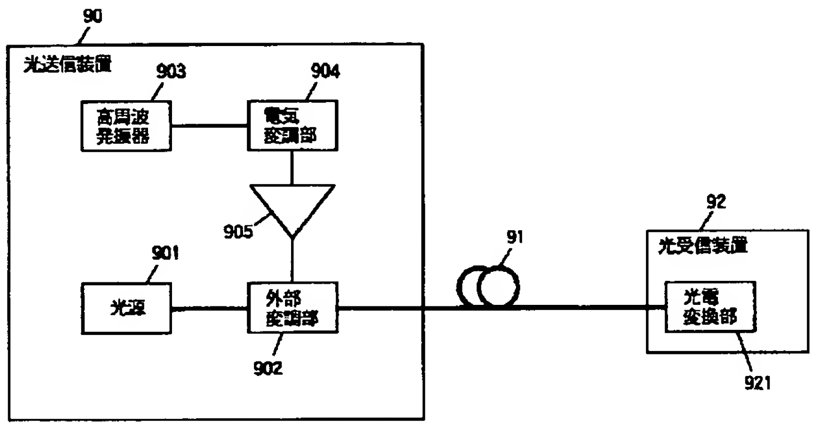

fc
fc

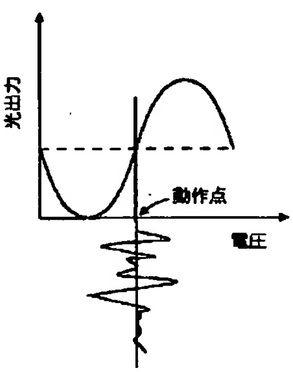
(1) (2)

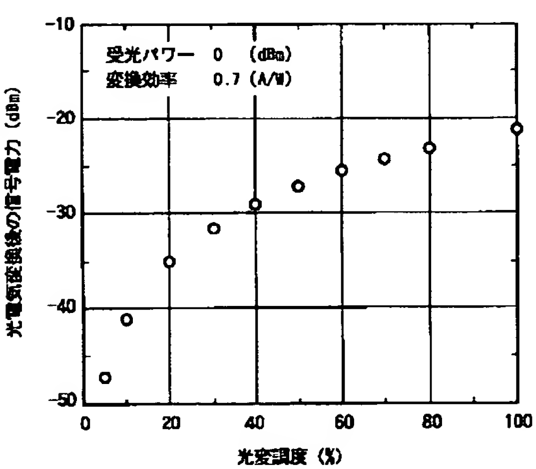

208
光分離部
ファイバ
グレーティング
(光合波部205aへ)
2081
2082
(光合波部205bへ)

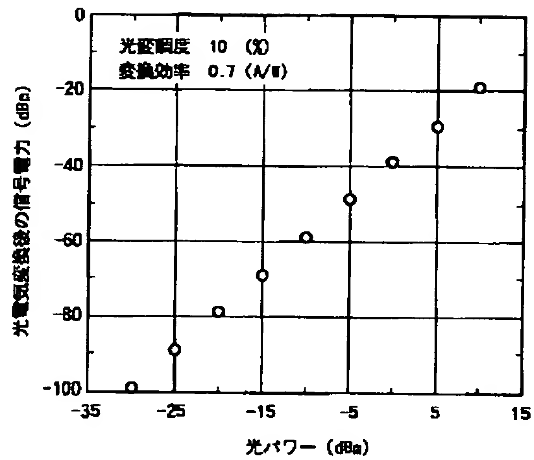

30
光送信装置
307
306
電気
変調部
高周波
発振器
301
302
308
光源
光分岐部
外部
変調部
光分離部
303
304
305
光合波部
31a
32a
光受信装置
光電気
変換部
321a
31b
32b
光受信装置
光電気
変換部
321b


12
光受信装置
10
11
121
光送信装置
光分離部
光電気
変換部
122a
122b
光電気
変換部

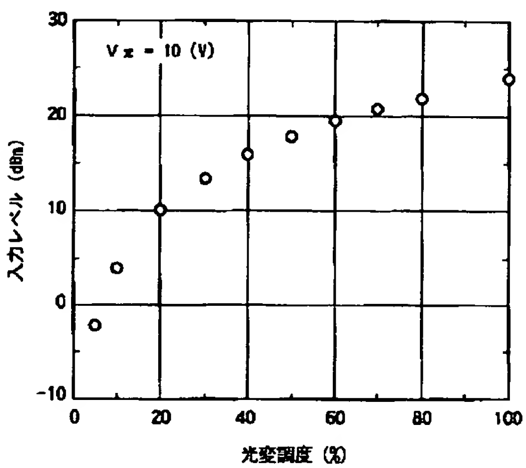

90
光送信装置
903
904
高周波
発振器
電気
変調部
905
92
91
光受信装置
901
光源
外部
変調部
光電
変換部
902
921


光出力
動作点
電圧


-10
受光パワー　0　(dBm)
変換効率　0.7 (A/W)
-20
-30
-40
-50
0
20
40
60
80
100
光電気変換後の信号電力（dBm）
光変調度（%）



光変調度　10　(%)
変換効率　0.7 (A/W)
光電気変換後の信号電力 (dBm)
0
-20
-40
-60
-80
-100
-35
-25
-15
-5
5
15
光パワー (dBm)



Vπ = 10 (V)
入力レベル (dBm)
30
20
10
0
-10
0
20
40
60
80
100
光変調度 (%)